A RAIN-GAGE OF STANDARD COMMERCIAL MATERIALS AND PARTS

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SYNOPSIS

To meet the need for a rain-gage that may be constructed of materials available in any community, it is proposed to make the collector 5.359 inches in diameter so that one-hundredth of an inch of rain in the gage will equal one fluid dram, thus permitting the water to be measused in a commercial graduate such as may be found in drug stores. Exactness in construction is required in but one part, a small brass ring at the top, and the cost is correspondingly lessened. Features shown by experience to be important are retained. Description and illustrations in enough detail to show how to construct the gage are given.

In English-speaking countries the recognized unit employed in rainfall measurement is one-hundredth of an inch, and it has been the practice to make gages 5, 6, 8, 10, or 12 whole inches in diameter. The quantity of water representing one-hundredth of an inch in a gage of any of these diameters is arbitrary, and hence its measurement requires either a specially constructed measuring tube and stick or a specially made graduate with arbitrary scale divisions, none of which are obtainable through ordinary channels of trade.

However, if a gage be so constructed that the amount of water represented by the unit of measurement agrees with an established unit of capacity, the measuring vessel employed in commercial transactions, and hence available almost anywhere, may be used to measure the rainfall. Upon examining the various established units the fluid dram is found to be suitable to the purpose, as it is large enough to permit identification, and at the same time the number of fluid drams corresponding to an ordinary rain is a quantity of water that may be easily handled. The corresponding gage diameter, 5.359 inches, is within the limits set by the results of experiments as desirable and being nearer the smaller limit involves a smaller amount of materials, which in turn means lower cost.

The degree of accuracy reasonably expected in measuring liquids may be taken from the tolerances given in Bureau of Standards Circular No. 61, with suitable application to the particular vessel in use. A few examples will show how the tolerances would affect rainfall measurements made in conical glass graduates such as are used in drug stores, and in some common commercial vessels.

Vessel	Capacity, rainfall	Probable error
	Inches	*Inches*
1-ounce conical graduate	0.08	0.002
2-ounce conical graduate	.16	.003
8-ounce conical graduate	.64	.007
1-gill commercial measure	.32	.02
½-pint commercial measure	.64	.02
1-pint commercial measure	1.28	.03
1-quart commercial measure	2.56	.04
½-gallon commercial measure	5.12	.06
½-pint milk bottle	.64	.02
1-pint milk bottle	1.28	.03
1-quart milk bottle	2.56	.04

In using the larger graduates there is an additional source of error in the need for eye interpolations between the markings, which are 1 fluid ounce, or 0.08 inch, apart. It is therefore best to use the smaller graduate. In actual trial a 16-dram graduate purchased at a drug store in Washington for 60 cents has been found to be quite satisfactory, although somewhat tedious to use in the case of heavy rains, because repeated fillings are required. However, an observer possessed of a graduate may easily calibrate several bottles of different capacity as an aid to expeditious measurement.

The following typical test shows the degree of accuracy with which water can be measured to fluid drams in a graduate marked in half ounces up to 4 ounces and in whole ounces from 4 to 16 ounces:

Actual drams (precise)	Reading (ounces), conical graduate	Drams, conical graduate	Correction, if rainfall were measured
1.35	⅛	1	0
2.4	¼	2	0
5.1	½	4	+0.01
14.8	1⅞	15	0
26.5	3⅜	27	−0.01
40.2	4⅞	39	+0.01
52.6	6⁴/₈	52	+0.01
64.3	8	64	0
82.9	10⅜	83	0
99.1	12⁴/₈	100	−0.01
122.8	15⅜	123	0

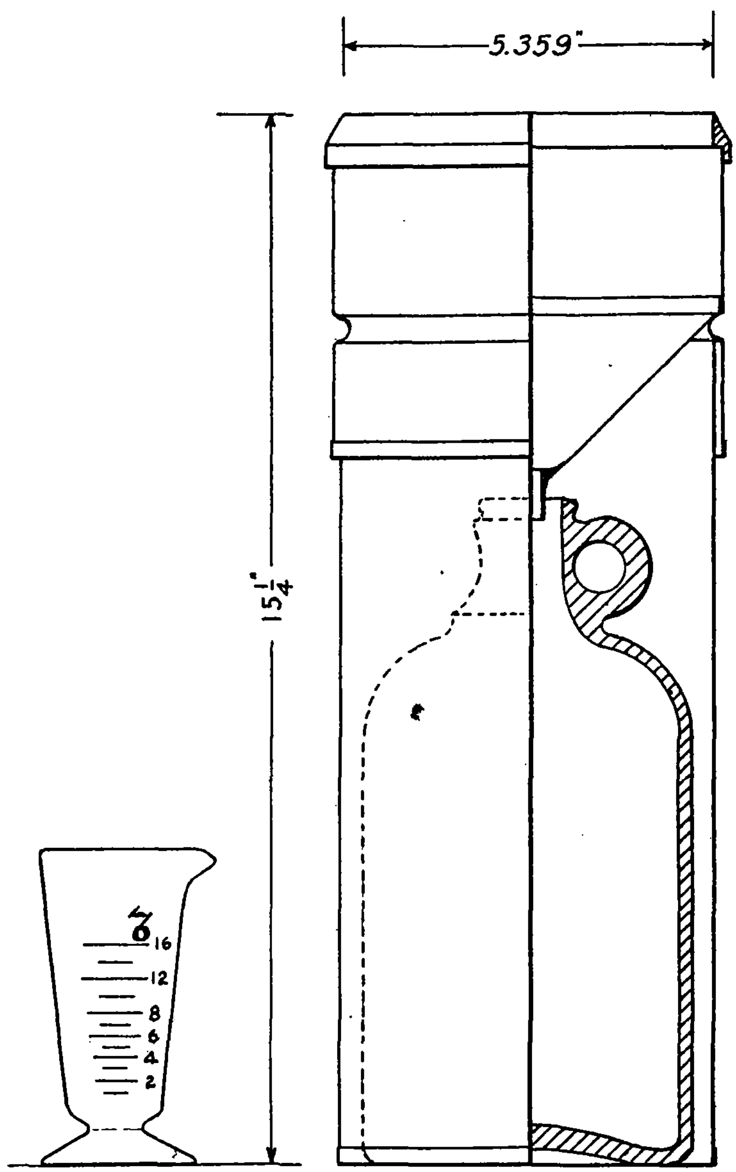

FIG. 1.—Construction details of the 5.359-inch rain-gage

A number of additional trials by different observers gave similar results, and the conclusion is that since the errors are well within the degree of accuracy expected in rainfall measurement the method is practical. A few actual rainfalls have been satisfactorily measured in a gage constructed in accordance with this plan. It is

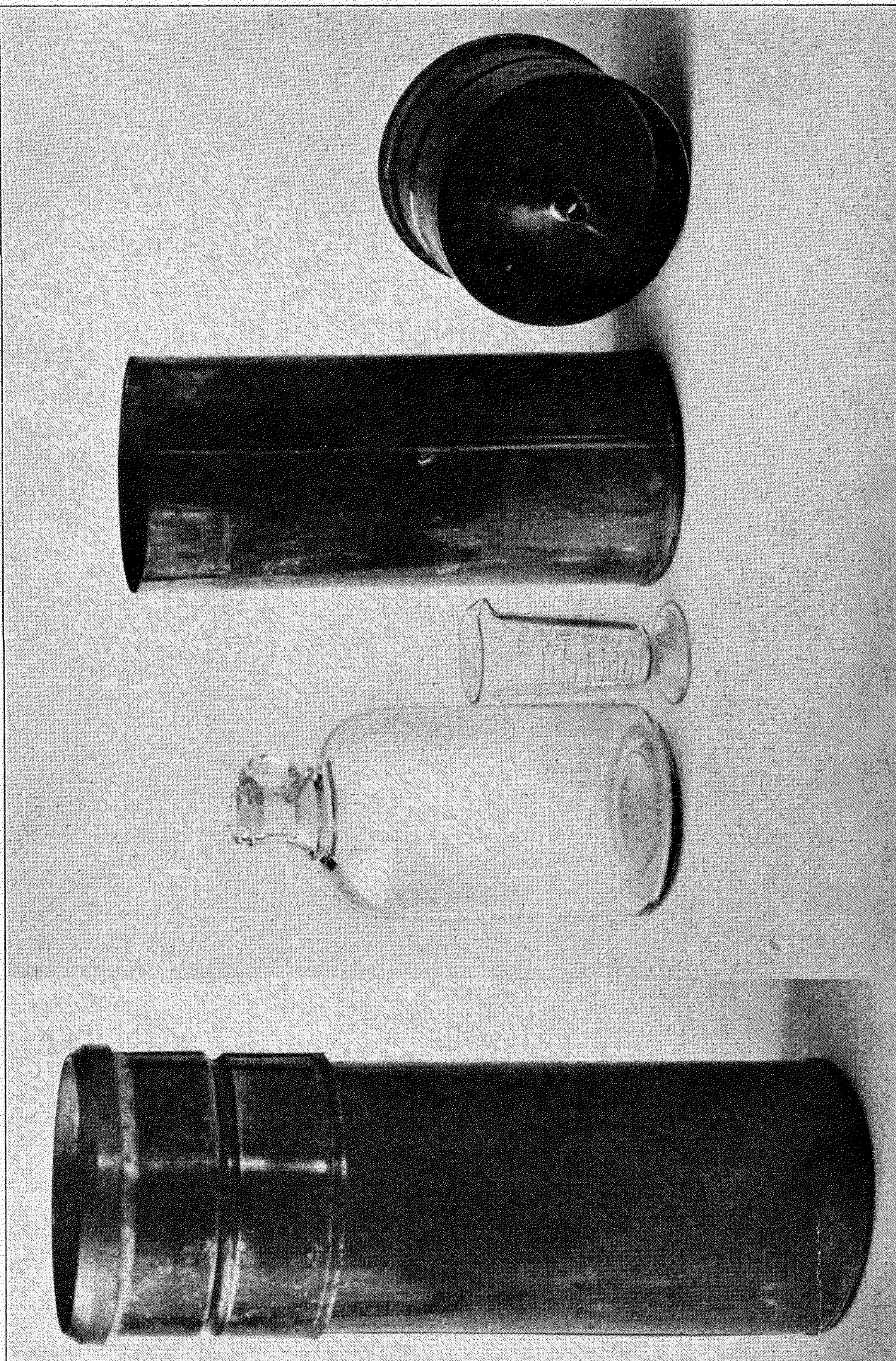

FIG. 2.—The rain-gage unassembled and assembled

recognized that a cylindrical graduate tapered at the bottom and having a capacity of 50 drams or more would be convenient; but it would probably not be found in the open market. A detailed description of the gage, with illustrations follows. A model is also available for examination at the Weather Bureau office in Washington.

DESCRIPTION OF FLUID DRAM RAIN-GAGE

The assembled gage is cylindrical, with outside diameter 5⅞ inches, and over-all height 15¼ inches, designed upon the general plan of the Snowdon rain-gage, well known in England, but with dimensions and parts chosen with a view to construction from standard material. The complete instrument consists of the following parts:

1. *The body.*—This is a sheet copper, cylindrical can, 12 inches deep, and with diameter as near to 5.359 inches as is practicable in construction. This can may also be used as a snow gage. Remembering that the probable error in the catch of snow is much greater than in the catch of rain, it will be apparent that if the diameter of the copper can approximates the above value, snow collected in it may, when melted, be measured in the glass graduate.

2. *The funnel collector.*—This is a sheet-copper cylinder 5.6 inches inside diameter by 4½ inches long, with the funnel proper soldered to the sides halfway up. The upper half of the cylinder gives depth to the collector. The lower half telescopes over the gage body for a distance of about 2 inches. The funnel proper is made with a 45° slope to a central outlet formed by soldering in a piece of brass tube ⅜-inch inside diameter by 1-inch long to form a discharge spout that terminates about 1 inch below the lower rim of the cylinder. A groove rolled in the cylinder serves to provide a definite stop for the funnel proper, gives additional stiffness to the construction, and forms a stop when the funnel is placed in position on the gage body. To the top of the funnel is soldered a stiff brass ring. This ring is important since it defines the area of collection. Its inside diameter must be turned true to 5.359 inches, with assurance that the actual result is within 0.01 inch of the specified diameter, and from the top the metal must be cut away to produce a slant outward and downward about 60° below the horizontal in a way to form a knife edge to "split the drops of rain." The brass ring is rabbeted out one-eighth inch on its lower inner side to form a recess into which the copper funnel may be soldered. Probably the best procedure is to have a molder make a solid cast brass ring three-fourths inch high by three-eighths inch thick by 5⅞ inches outside diameter and have a good machinist do the finishing work.

3. *The retaining bottle.*—This is simply a half-gallon commercial glass vinegar jug intended to hold the rain and prevent evaporation until a measurement is made. If it should be broken through freezing or otherwise another may easily be obtained. It centers loosely in the gage body, thus directing the discharge spout from the funnel into the neck of the bottle without special effort.

4. *The graduate or measuring vessel.*—It is best to have a graduate marked in fluid drams because of the greater accuracy attainable. However, the total capacity of a graduate so marked is generally only 16 fluid drams, and hence it is a good plan to have at hand several auxiliary bottles which may be calibrated by pouring into them from the accurate graduate enough water to bring the height to a point which should be marked in the neck. These calibrated bottles expedite the measurements of heavy rains. Actual trials by different observers have demonstrated that in 16-ounce graduates marked in fluid ounces the necessary eye interpolations between the lines can be made with a reasonable degree of accuracy. Readings are always made by looking horizontally across the lowest part of the curved meniscus of the water surface.

5. *Conversion.*—In a gage constructed as above 1 fluid dram equals 0.01 inch, 1 fluid ounce equals 0.08 inch, 1 pint equals 1.28 inches, 1 quart equals 2.56 inches, one-half gallon equals 5.12 inches. In case of an unusually heavy rain the jug may overflow, but we still have a reserve capacity in the can to care for a total rain of 10 inches.

6. *Cost.*—The cost of a sample gage made according to these specifications was as follows: Copper body and funnel, $4; brass rim, $1.78; retaining bottle, $0.15; 16-dram graduate, $0.60; total cost, $6.53; overhead and profit not considered.

7. *Manufacture.*—The best method of construction is to have the entire gage made by a competent manufacturer of meteorological instruments; but where such manufacturers are not accessible the brass ring can be cast by a molder, then turned true by a machinist, then taken to a sheet-metal worker to be built into the gage. This method of construction places upon the owner final responsibility for the accuracy of the collector.

THE CRITERIA OF A COLD WINTER

By ALFRED J. HENRY

The need is often felt of criteria to briefly and precisely express the degree of abnormality of a season, more particularly the winter. Common usage employs the adjectives hard, severe, or mild and open, to distinguish between the two extremes usually experienced. Common usage, however, is notoriously inexact and different persons use the above-mentioned adjectives in a different sense.

The writer has sought to classify winters as a whole, meaning the usually recognized winter months of December, January, and February, according to the abnormalities of temperature which these months exhibit. He has also attempted, although unsuccessfully, to attach weights to the different winters based on the money loss suffered by transportation and agricultural interests as a direct result of adverse weather.

At present there is no organization under Government control through which a census could be made of the economic results of severe winter weather, and, moreover, difficulties arise in the exact delimitation of the areas that suffered economic loss. These and other conditions operate to restrict the useful criteria to those of a meteorological nature.

The chief meteorological criteria must of necessity be temperature and precipitation, of which the latter, in winter, is of secondary importance.

Temperature data may be utilized in several ways, for example, in order to determine the months of greatest cold, the number of days with minimum below an arbitrarily selected figure may be compiled; or, instead of using absolute minima, departures from the monthly means may be used. Any temperature data utilized must be arbitrarily selected with reference to the climate of the region, particularly the degree of continentality that obtains. Numerous trials have been made in order